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United States Department of Agriculture
Agricultural Research Service

Report
of
ANNUAL CORN AND WHEAT UTILIZATION CONFERENCE

Northern Utilization Research and Development Division
and
Corn Industries Research Foundation
Technical Committee

Peoria, Illinois
April 3, 1962

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FOREWORD

The Annual Corn and Wheat Utilization Conference was held on Tuesday, April 3, 1962, at the Northern Regional Research Laboratory. Attending were members of the Corn Industries Research Foundation Technical Committee, representing 11 cereal processors, and staff members from the Northern Utilization Research and Development Division with interests in cereals research. Reports of research at the Northern Division were presented, ideas were exchanged, and a number of areas where additional research is needed were outlined.

SUMMARY

Dr. F. R. Senti opened the conference and briefly outlined the research program of the Division on cereals, oilseeds, and new crops.

Further studies on fractionating high-amylose corn starches by the hydration-freezing pretreatment followed by extraction with hot water, and characterization of the fractions were reported. A genetic factor favorably influencing wet-milling characteristics in high-amylose corn was described and some gene-dosage effects were noted.

Fundamental studies of nonaqueous alkali metal complexes with carbohydrates have established the order of reactivity for a number of them. Possible practical application might be in separating carbohydrate mixtures. Improved analytical techniques have permitted a more thorough analysis of nonprotein nitrogenous constituents of corn steep and dry- and wet-milled corn products. Studies on the intrinsic viscosity of reduced dialdehyde starches with varying degrees of oxidation established a range of properties and indicated that a marked degradation occurred when tap water of pH 7.5 was substituted for distilled water as a wash after oxidation.

The preparation of xanthates of cereal starches and flours was described and application of these "cereal pulps" with wood pulps in papers was outlined. The addition of cereal pulps to wood pulps gave considerable improvement in most properties, in some cases at addition levels as high as 45 percent.

The microbial production of beta-carotene by mated strains of Blakeslea trispora was described. Practical levels of production have been attained on a medium containing acid-hydrolyzed soybean meal and corn, vegetable oil, nonionic detergent, citrus pulp or citrus molasses, and deodorized kerosene.

The general discussion brought out the viewpoint that the corn industries prefer to do research on product applications themselves, but are very much interested in the fundamental information which is needed to explain reactions and properties and to provide the avenues for product and process improvements. Some particular areas in which they feel NU should do research were outlined. These included mechanics and kinetics of adhesion, types of bonding, granular structure of starch, pyrodegradation, minor constituents, and analytical methods.

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service

Program

ANNUAL CORN AND WHEAT UTILIZATION CONFERENCE

Northern Utilization Research and Development Division
and
Corn Industries Research Foundation Technical Committee

Peoria, Illinois
April 3, 1962

Morning Session

8:30 a.m. Introduction F. R. Senti
9:00 a.m. Further Studies on High-Amylose Starch E. M. Montgomery
9:30 a.m. Alkali Metal Complexes with Carbohydrates J. A. Rendleman
10:00 a.m. Intermission
10:15 a.m. Nonprotein Nitrogenous Constituents of Wet-
and Dry-Milled Corn Fractions..... D. D. Christianson
10:45 a.m. Effect of Genetic Background on Milling
Responses of High-Amylose Corn R. A. Anderson
11:15 a.m. Intrinsic Viscosity of Reduced Dialdehyde
Starch W. C. Schaefer
11:45 a.m. Group Photograph
12:00 Noon Luncheon

Afternoon Session

1:00 p.m. Starch Xanthates--Preparation and Reaction R. A. Buchanan
1:30 p.m. Starch Xanthates in Cereal Pulp-Wood
Pulp-Paper Blends..... C. R. Russell
2:00 p.m. Microbial Production of Beta-Carotene A. Ciegler
2:30 p.m. Open Discussion

INTRODUCTION

F. R. Senti

Dr. F. R. Senti opened the Conference by welcoming visitors and introducing those in attendance. The following research areas of the Division were outlined:

Cereals--Composition studies include carotenoids and minor constituents of corn and electrophoretic studies on the proteins of corn and wheat. The high-amylose corn project included analyses of almost 18,000 samples last year for the cooperating USDA workers at the Missouri Experiment Station and the Bear Hybrid Corn Co. Increasing numbers of samples have been in the 70-80 percent amylose range and improved processing characteristics of some high-amylose lines give more encouragement for the ultimate success of this crop.

Research on dialdehyde starch is now confined to applications, reactions, and properties. Allyl acetals show water resistance and marked adherence to glass. Superior wet-strength papers and reactions with casein are promising applications. Starch acetals and ketals are also being studied.

Physical-chemical studies include density and crystallinity of starch granules and properties of starches in solution.

Fermentation studies include the basic studies of the Culture Collection and the Pioneering Laboratory; research on microbial polysaccharides which are now approaching commercial development; production of bacterial spores for control of Japanese beetle; and studies of fleshy fungi. Some species of fleshy fungi were found containing significant amounts of rubber (polyisoprene), but they did not produce any when grown on synthetic media.

Oilseeds--Research on soybean oil is centered on studies to produce a stable cooking oil. Progress has been made in separation of isomers and identification of degradation products with the mass spectrometer. Other research involves preparation of aldehyde oils by ozonization and reduction. These have interesting industrial possibilities.

Satisfactory linseed oil emulsion paints for exterior use have been produced and cyclic fatty acids from linseed oil have shown some interesting new properties.

New Crops--Research has reached the engineering phase and a method has been developed for producing nontoxic meal from mustard and Crambe abyssinica seed. The oil of these species is particularly high in erucic acid. Screening studies are continuing to find other unusual oils, proteins, seed gums, and potential annual fiber crops.

FURTHER STUDIES ON HIGH-AMYLOSE STARCH

Edna M. Montgomery

The preparation of aqueous solutions of amylose from high-amylose corn starch was described including the fundamental chemistry involved in (1) the solubilization of amylose in the granular starch by a hydration-freezing pretreatment and (2) selective extraction of amylose from the starch in boiling water or in an autoclave and removal of the amylopectin from the dispersion by centrifugation.

Amylose concentration in the aqueous extracts was as high as 4.5 percent. In general, yields of amylose extracted in two or three operations were from 85 to 95 percent of the amylose present for all starches investigated. Purity of amylose in extracts was 85 to 89 percent by iodine binding for SO₂-steeped starches, 90 to 92 percent for water-steeped or undegraded starches. Purity of amylose was increased to 95 percent by the addition of ethanol or diethyl dithiocarbamic acid to the pretreating solvents.

Also discussed were simple techniques for increasing low yields of amylose to normal levels from overdried starches or starches from unusual corns.

Amylose was extracted in good yields from most starches in boiling water but increases in rate of amylose extraction and in yield in one extraction were observed if temperature of the dispersion was increased to 105° or even for some starches, to 120° C.

Fractionation of approximately 30 high-amylose corn starches covering 7 levels of amylose content and 4 steeping procedures was carried out. The starches were undried or dried in forced-draft ovens.

Discussion

Of all the high-amylose corn samples studied, the 67 percent amylose sample which showed better wet-milling characteristics, also showed other unusual properties particularly in having an abnormally high content of free fatty acid for an otherwise sound corn.

ALKALI METAL COMPLEXES WITH CARBOHYDRATES

J. A. Rendleman

In nonaqueous media, polyhydroxy carbohydrates can complex with alkali metal hydroxides. Two types of complexes are possible, the acidity of the carbohydrate determining which one will form. An acidic compound, such as kojic acid, loses a proton to produce a salt which subsequently complexes with a second molecule of carbohydrate. On the other hand, a nonacidic compound, such as glucose or sorbitol, gives an adduct without losing a proton. Ebullioscopic and electrophoretic measurements have offered good support for the latter nonsalt type of complex.

Both types of complexes may be prepared by adding a dilute alcoholic alkali metal hydroxide solution to a solution of the carbohydrate in N-methyl-2-pyrrolidinone. Although in many instances the complex readily precipitates from solution, the addition of ether or ethyl acetate is occasionally necessary. All of the nonsalt-type complexes are hygroscopic.

With a few exceptions, the hydroxides of lithium, sodium, potassium, and cesium interact with simple, nonacidic polyhydroxy carbohydrates to give complexes whose carbohydrate-alkali metal hydroxide ratios are 1:1, 2:1, 2:1, and 2:1, respectively. The reason for the difference between lithium hydroxide and the other alkali metal hydroxides probably lies in the difference in cationic surface area. Differences between sodium, potassium, and cesium are usually small; however, several significant deviations from a 2:1 ratio have been observed, indicating the importance of not only cationic size, but also carbohydrate stereochemical configuration.

In nonaqueous solution, the stability of an alkali metal hydroxide complex varies with the polarity of the solvent; the lower the polarity, the greater is the stability. For example, in dilute methanolic solution, the complex is almost entirely dissociated into its component parts, whereas in ethanol appreciable complexing is the rule. Complex species in solution are probably un-ionized, as evidenced by their static behavior during electrophoretic treatment in both methanolic and ethanolic media.

The problem of determining which hydroxyl groups in a polyhydroxy compound are involved in complexing remains unresolved. Our work has shown that at least two hydroxyls are necessary and that they must be in close proximity to each other. The greater the number of hydroxyl groups, the greater is the stability of the complex. Two additional factors, stereochemistry and carbohydrate basicity, also seem to influence stability.

Relative complexing ability studies have provided the following decreasing order of reactivity towards alkali metal hydroxides: oligosaccharides > aldohexoses > aldopentoses. Also, arabinose > xylose > lyxose > ribose; and glucose > sorbitol.

Sodium compounds such as ethoxide, bromide, iodide, formate, acetate, and propionate give 2:1 type complexes whose stabilities differ from that of the corresponding 2:1 type sodium hydroxide complex. It is possible that practical use can be made of such differences in stability to effect separations of carbohydrate mixtures.

Our studies in nonaqueous media have amply shown that nonacidic polyhydroxy carbohydrates possess a definite amount of nucleophilic character. An extreme example of this behavior is cellulose, which acquires a net positive charge when in contact with alcoholic sodium hydroxide. In aqueous media the charge is negative. Although most all polyhydroxy compounds become negatively charged in aqueous alkali, the mechanism by which this occurs has never been adequately proved. As has been frequently suggested, proton removal to give an alkoxide type of ion may be responsible; yet, the true explanation may not be as simple as this. An alternative explanation could be complex formation in which hydroxide ions are absorbed in preference to cations.

Discussion

The presence of water markedly affects the formation of complexes. Different solvents also give different complexes. Arabinose plus KOH complexes only in ratio of 1:1; other pentoses 2:1. Some information on structure is gained by studies of the electrophoretic migration of the complexes.

NONPROTEIN NITROGENOUS CONSTITUENTS OF WET- AND DRY-MILLED CORN FRACTIONS

D. D. Christianson

Despite the increased industrial outlets for corn products, 95 percent of the grain or its milled fractions are still used for animal feeds, human diets, and fermentation media. The nonprotein nitrogenous constituents of corn were investigated because of their important role in nutrition, even though these substances are present in the grain in small amounts. Recent developments in chromatographic methods for separation of amino acids and quaternary nitrogen compounds have made possible a more complete study of the kinds and amounts of nonprotein nitrogenous substances in the grain, in isolated germ, bran, and endosperm, and in corn steep liquors. These constituents were isolated from the grain or steep liquor solids by extraction with alcohol solutions, separated by ion exchange chromatography, and determined individually by specific procedures.

Approximately 2 percent of the total nitrogen in corn is alcohol-extractable nonprotein nitrogen and one-half of this is free amino acids. The four major free amino acids in corn and its anatomical fractions are asparagine, proline, alanine, and γ -amino butyric acid. These comprise over 75 percent of the free amino acid nitrogen. Choline and trigonelline are the major quaternary nitrogen compounds in the corn grain. The germ fraction contains the highest concentration of free amino acids and quaternary nitrogen compounds.

Thirty percent of the total nitrogen in steep liquor is present as free amino acids with an additional 45 percent as peptide-bound nitrogen. Gamma-amino butyric acid, proline, alanine, and leucine are the major amino acids in the liquor. Although the free amino acids in corn are extracted from the grain during steeping, the composition of corn steep liquors indicates that decomposition of the corn proteins due to enzymatic, bacterial, and acid hydrolysis is the major source of nonprotein nitrogen. Comparison of amino acids in grain and steep liquor indicates other metabolic or fermentative transformations have also occurred during steeping. The high level of amino acids provides a ready source of available nitrogen for animal feeds and microbial media. One percent of the corn steep liquor nitrogen is present as quaternary nitrogen compounds consisting principally of choline.

Information on changes in the nonprotein nitrogenous constituents in the grain, its anatomical fractions and corn steep liquors may provide a key to the control of the composition and quality of these products during drying, storage, and milling.

Discussion

A simple test for overheating of corn is needed. Close attention should be paid to the minor constituents, looking for any which are heat-labile and might be used as indicators of heat damage. Drying is critical and changes which occur under various drying conditions are also of interest. Additional studies which would be of interest would be comparisons between kiln-dried and normal corn steep liquors.

EFFECT OF GENETIC BACKGROUND ON MILLING RESPONSES OF HIGH-AMYLOSE CORN

R. A. Anderson

Two series of special high-amylose corn samples, grown by Bear Hybrid Corn Company, were wet-milled to study the effects of certain genetic factors on milling response. In the first group of samples, amylose and protein content were varied, with and without the presence of the so-called "milling factor" or "M". This factor is thought to be responsible for the improved milling noted in several of the high-amylose corns. The milling data indicated beneficial results due to milling factor, with an 82.7 percent recovery of starch containing 0.48 percent protein. While it is believed that amylose content plays a minor role in milling properties of the corn, it is not known whether protein content plays a similar part. We cannot conclusively say that either the milling factor or protein is responsible for better processing characteristics; however, their effects have been observed in these tests. Unfortunately, the samples needed to complete the study and perhaps establish the responsible factor could not be grown this year.

In the second group of corn samples, the genetic position in the double cross hybrid and the concentration of the milling factor were varied, without regard to amylose or protein content. The results obtained from processing these samples indicated that better milling occurred as the concentration of M increased. At the lower concentration of M, the starch recovery generally ran under 70 percent. As the concentration was increased toward its maximum, the recovery improved, ultimately reaching 82.7 percent. A similar improvement was noted in the protein content of the starch. There appeared to be some effect on the kernel volume increase during steeping from the degree of dominance of certain genetic positions of M.

These studies will aid the plant breeder in providing direction for improving processing characteristics of high-amylose corn hybrids.

Discussion

Samples were milled consecutively following as nearly identical procedure as possible. Dr. Evans commented that in commercial trials of high-amylose corn his company, too, had noticed marked increases in volume of steeps compared to regular corn.

INTRINSIC VISCOSITY OF REDUCED DIALDEHYDE STARCH

W. C. Schaefer

A study was made on the effects of reaction conditions and isolation techniques on solution properties of periodate-oxidized corn starch having from 5 to 87 percent of the anhydroglucose units oxidized to the dialdehyde structure followed by reduction to the polyol by potassium borohydride to impart alkali stability. Samples were prepared for viscosity and ultracentrifugation studies by dispersion in 0.5N potassium hydroxide containing 25 percent (w/v) urea.

Except at low levels of oxidation, where minor amounts of insoluble materials were encountered, samples oxidized in paste form at 1° C. and reduced with borohydride were completely soluble in the dispersing medium used. In contrast, when samples oxidized in granule form at low and intermediate levels were washed with distilled water, major amounts of insoluble material were encountered. At the 87 percent level of oxidation, however, granule samples washed with distilled water and paste samples had almost identical solubilities, intrinsic viscosities, and sedimentation coefficients. Oxidation of granules at 35° C. resulted in major amounts of insoluble material at all levels of oxidation.

Extensive degradation resulted in all samples when tap water at pH 7.5 was substituted for distilled water as a wash after oxidation. A small but detectable amount of degradation resulted when products were dried at 105° C. instead of at ambient temperature.

Intrinsic viscosity values for paste-oxidized samples ranged from 1.33 to 0.51, and sedimentation coefficients ranged from 41 to 18S (Svedberg units), respectively, as the degree of oxidation was increased from 5 to 87 percent of the anhydroglucose units.

STARCH XANTHATES--PREPARATION AND REACTIONS

R. A. Buchanan

The paper industry in this country currently uses nearly 1 billion pounds of starch and related materials annually in sizing agents and adhesives. This figure amounts to an average level of incorporation of about 1 percent. If economic methods could be developed which would use a greater percentage of such cereal products in paper, the industrial utilization of starch would be greatly increased.

Many natural polymeric materials such as proteins of wheat gluten and wool have important properties which are due to thiol and disulfide groups present in their molecules. Thiol groups may be oxidized to produce disulfide crosslinkages between protein chains. The unique properties of thiol-disulfide systems suggested that water-soluble derivatives of starches and cereal products capable of being insolubilized by coupling reactions be investigated for incorporation in paper.

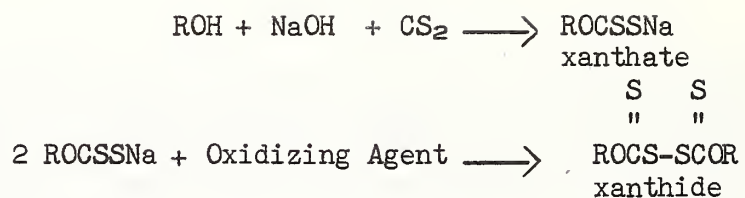
Xanthates were chosen for the initial studies because:

1. They are water-soluble and contain a thiolthiocarbonyl group through which they may be insolubilized by disulfide coupling analogous to the cysteine-cystine system in proteins.
2. The xanthation reaction is applicable to many substances; those containing hydroxyl, amino, and thiol groups.
3. The reaction is readily carried out and the reagents, carbon disulfide and sodium hydroxide are both inexpensive.

Starch and related xanthates have not been used heretofore in the production of paper, either in the manner or in the amounts employed in the present study. However, the xanthation of starch and cereal products will apparently be much more economical than the xanthation of cellulose because starch, unlike cellulose, need not be pretreated and aged with alkali to achieve rapid xanthation. Starch xanthates of lower D.S. are soluble at more dilute alkali concentrations than cellulose xanthates.

Starch, flours, and related materials have been converted by known procedures to xanthates having different degrees of substitution, but usually in the range 0.05 to 1.0. After addition of a solution of cereal xanthate to a pulp furnish, the xanthates are precipitated on the wood pulp as the insoluble xanthide by means of one of several low-cost oxidizing agents. Chlorine, iodine, nitrogen tetroxide, and nitrous acid have been used successfully.

The reactions involved are:



Treating xanthates with heavy metal salts, such as zinc chloride, produces insoluble metal-xanthates, which may be used like xanthides in papermaking.

STARCH XANTHATES IN CEREAL PULP-WOOD PULP PAPER BLENDS

C. R. Russell

Procedures were described for wet-end addition and for subsequent chemical precipitation of insoluble cereal xanthides and of polyvalent metal xanthate salts on chemical or groundwood pulps. When used in papermaking, the products derived from xanthates of cereal starches, flour, bran, ground whole wheat, and chemically related materials have been termed "cereal pulps" for brevity. The xanthides also showed utility as coating adhesives.

The feasibility of incorporating cereal pulps at the wet end of a normal papermaking process is shown by the quality of papers made on a laboratory 10-in. fourdrinier machine. Experimentally, cereal xanthates were added to wood pulp furnishes at the chest and converted to xanthides in situ. Retention of cereal pulps is generally quite high and under certain conditions is nearly quantitative, even when the level of addition amounted to as much as 80 percent of the wood pulp. Xanthate D.S. within the range examined, from about 0.04 to 1.0, does not have a marked effect on retention, but retention is slightly greater with xanthates in the D.S. range of 0.37 to 0.75 than with those of lower D.S.

Except for tear, dry-strength properties of paper and wet-tensile strength of the permanent type generally increase up to a cereal pulp content of about 20 percent and then decrease as further quantities of cereal pulp are incorporated. With initially strong kraft pulps, strength increases have been obtained as high as 43, 25, 800, and 185 percent for burst, dry and wet tensile, and fold, respectively. In some instances strength properties, except for tear, have been maintained and, in fact, significantly increased in paper containing as much as 40 percent cereal pulp. At comparable levels of addition cereal pulps derived from xanthates in the D.S. range of 0.1 to 0.3 were nearly equivalent and somewhat superior to those derived from xanthates of lower or higher D.S. in improving strength properties of paper. Opacity of paper decreases and its resistance to penetration by water increases with increasing cereal pulp content.

Incorporation of cereal pulps with slow-draining, greaseproof pulps greatly decreases drainage time and gives a sheet with improved wet strength and greater transparency.

In newsprint, 4 percent cereal pulp was equivalent to 16 percent long-fiber pulp in increasing dry-strength properties, except for tear which was reduced. In addition, a tenfold improvement in wet-tensile strength was realized from the cereal pulp.

When used as coating adhesives, amylose-derived cereal pulps gave clay coatings having excellent wet-rub resistance and high wax pick. However, values for whiteness and brightness of the coatings were lower than those achieved with conventional coating adhesives.

The methods of preparation and use of cereal pulps in paper products were also found applicable to a variety of natural and synthetic materials, such as carbohydrates, polysaccharides, proteins, polyols, and chemically related substances.

Examination of data presented makes apparent not only the present incompleteness of information in a number of areas, but also the need to develop systematic and unequivocal data for a number of factors involved in preparation of xanthates, coupling of xanthates to form cereal pulps, and correlation of paper qualities with raw material and processing variables.

Discussion

Cereal xanthates can be isolated in the dry state. They have been held as long as 6 months and appear to be stable, but as isolated are difficult to dry. No studies have been made of various solvents for crosslinked xanthates, but they can be dispersed by cooking with alkali. Xanthides are not corrosive, xanthates are; but no serious problems of corrosion are anticipated. Aluminum salts do not precipitate as well as zinc. Cross-linking of commercial gluten gave complete recovery in insoluble form, but did not give the improved properties found with starch and flour.

MICROBIAL PRODUCTION OF BETA-CAROTENE

Alex Ciegler

The microbial production of β -carotene is based on the phenomenon that mated strains of the mold, Blakeslea trispora, produce higher yields of carotene than those obtained with the same organisms cultured separately. In a medium composed of acid-hydrolyzed soybean meal and corn, vegetable oil, detergent, and thiamin, the addition of a precursor, β -ionone, greatly enhanced carotene yields. Because cost calculations showed the process to be marginal and the carotene was found to be unstable in the dried mycelium additional work was directed towards further increases in yields and towards stabilization. A "half life" of 10 to 12 weeks was achieved by addition of an antioxidant, Santoquin, either to the dried mycelium or into the medium during the course of fermentation. Increased yields, 75 mg. carotene per 100 ml. of medium were attained by the addition of kerosene to the medium. Use of a deodorized kerosene gave a further increase to 85 mg. per 100 ml. of medium. The comparatively high-priced precursor, β -ionone, could be replaced by very low-cost agricultural byproducts such as citrus oils, citrus pulp, or citrus molasses with average yields of 100 mg. per 100 ml. of medium. These yields were reproduced in 20-liter tanks with a reduction in fermentation time from 5 to 3 days. The availability of β -carotene in the dried mycelium as a source of provitamin A will be tested by Michigan State University in poultry and swine under a contract now being negotiated.

Discussion

Analysis of carotenoids produced showed over 99 percent β -carotene; xanthophylls are present in relatively small amounts.

DISCUSSION

In opening the general discussion, Dr. Senti called for research ideas from the industries represented.

Dr. Scallet indicated that an informal subcommittee reviewed the proceedings of past conferences and noted from presentations that earlier suggestions have been used as a basis for NU research. Particularly discussed were areas in which industry is not in a position to work but NU can. The general philosophy was well expressed in the 1953 report and the following suggestions for research, which are not listed in order of importance, were compiled by the committee:

1. Hydrogen bonding in starch films, granules, and pastes from a quantitative and structural standpoint.
2. Molecular configuration of amylose in films and properties of films as related to methods of formation, and of conditions of drying and aging.
3. Granule structure and surface characterization. Comparative granule behavior and organization as function of type of starch.
4. Adhesion--mechanism and kinetics of adsorption of molecular types on cellulose fibers; relative to strength of paper; relative to molecular configuration.
5. Study on sensitivity of α -1,4 linkage in starch to acid hydrolysis.
6. Specificity of chemical derivatization reagents for amylose and amylopectin and interpretation.
7. Pyrolytic degradation of starch in different atmospheres and analysis of degradation products.
8. High temperature damage to corn--general studies and quick practical method for detecting.
9. Nondegradative method for analysis of sugars for reducing power--neutral solution.
10. Flavor components in starch with special reference to pregelatinized types.
11. Analytical techniques for determining traces of substituents on starch.
12. Improvement of the nutritional value of corn protein by genetic means. Analytical support.

13. Rotatory dispersion of all carbohydrates.
14. Analytical methods for detection and determination of insecticide and pesticide residues in grain and trace quantities in products.

Dr. Senti commented that the last item would have to be considered under marketing research. In regard to potential methods, electron capture spectroscopy has great sensitivity. Extremely small amounts of chlorinated compounds can be detected and the method has potential for analysis of very minute amounts of residues.

There was additional discussion on the importance of studies on starch films and basic work on adhesives where there are a number of practical problems which would be helped by a basic understanding of structural organization in films and pastes.

Mr. Peckham commented that starch is like rubber in versatility--just as synthetic rubbers are superior to natural rubber for certain applications, new modified starches are superior to ordinary starch for specific uses. Dr. Senti stated that one needed improvement is to stabilize the α -1,4 linkages. Dr. Wolfrom (Ohio State University) is conducting work under a NU contract on 2-amino derivatives. Also the bacterial polysaccharides developed at NU are another approach to the conversion of starch to polymers with improved properties.

Adhesion of starch to cellulose is of major importance. The mechanisms of bonding, including studies on clays and coatings, textiles, and glass, are also important. Some problems involve the surface chemistry of fiber hydration and bonding and how adhesives improve the bond. TAPPI is interested in all details of starch adhesion including binding of pigments. A number of other questions were raised for which we need answers: What structures of starch films contribute to physical properties? What can be done to control flexibility and stretchability of starch films? How do you get more starch absorbed, and more effectively absorbed? How does starch retention vary with time? What factors affect adhesion in a limited time? What are the effects of crystallinity on film properties and bonding?

The comparative value of fundamental versus applied and development research was discussed at some length. Opinion expressed by CIRF representatives was unanimously in favor of basic research. The representatives speaking were in technical positions with their respective companies ranging from research chemists to directors of research. They believed that practical development of new processes and new products by the U.S. Department of Agriculture, whether patented or only published in technical journals, preclude the accrual of advantage to a potential commercial user or producer of a new process or product that was available to the general public. This position, which has been stated many times over the years, brings to the fore the problem of how to assess the value of fundamental or applied research which stops short of industrial applications.

Perhaps a good case can be made for research that is not carried to commercial application or development. The evidence in justification of such a research program can come only from the industries who build on this research to the ultimate benefit of American agriculture. The intangible nature of the many pieces of fundamental data involved in practical accomplishments makes a quantitative evaluation difficult.

However, it was believed that a start along such lines might be possible and if adequately presented to the responsible administrators and legislators would lead to increased recognition and support for fundamental research.

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service

ANNUAL CORN AND WHEAT UTILIZATION CONFERENCE

Northern Utilization Research and Development Division
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Peoria, Illinois
April 3, 1962

List of Attendance

CORN INDUSTRIES RESEARCH FOUNDATION TECHNICAL COMMITTEE

Corn Industries Research Foundation, Inc., Washington, D.C.

J. T. Goodwin, Jr., Technical Director

American Maize-Products Company, Roby, Indiana

J. W. Evans, Vice President - Research

E. L. Powell, Assistant Director of Research

Anheuser-Busch, St. Louis 18, Missouri

B. L. Scallet, Associate Director, Central Research Department

R. J. Sumner, Director, Central Research

Clinton Corn Processing Company, Clinton, Iowa

A. D. Campbell, Assistant Research Director

G. T. Peckham, Jr., Research Director

Corn Products Company, Argo, Illinois

Harry Gehman, Director of Research

R. J. Smith, Assistant Director of Research

Hercules Powder Company, Wilmington, Delaware

R. W. Butler, Technical Representative, Virginia Cellulose Department

The Hubinger Company, Keokuk, Iowa

J. M. Seitz, Director of Research

Lee Elizer, Chemist

Glen C. Glasscock, Technical Sales

Jack Harness, Assistant Director, Technical Sales Service

Roger Yarbrough, Chief Chemist

Keever Starch Co., 324 Dering Road, Columbus, Ohio

F. M. Relle, Research Chemist

National Starch and Chemical Corporation, Plainfield, New Jersey

O. B. Wurzburg, Associate Director of Research
Morton Rutenberg, Section Leader, Starch Research

Penick and Ford, Ltd., Cedar Rapids, Iowa

J. E. Killinger, Vice President
C. C. Kesler, Research and Technical Director
Erling Hjermstad, Research Chemist

A. E. Staley Company, Decatur, Illinois

J. A. Bralley, Vice President - Research and Development
E. E. Fisher, Head, Exploratory Section, Chemical Department

Union Starch and Refining Company, Granite City, Illinois

J. P. Casey, Director of Research and Development
R. E. Pyle, Research Director

NORTHERN UTILIZATION RESEARCH AND DEVELOPMENT DIVISION

F. R. Senti, Director
W. C. Witham, Assistant Director
L. L. McKinney, Assistant Director
D. L. Miller, Assistant Director
H. M. Teeter, Assistant Director
J. E. Hubbard, Assistant to Director
W. C. Schaefer, Assistant to Director
W. K. Trotter, Agricultural Economist
K. R. Majors, Extension Grain Utilization Specialist

Cereal Products Laboratory

C. E. Rist, Chief	C. L. Mehltretter	B. T. Hofreiter
R. A. Buchanan	T. R. Naffziger	D. Trimmell
A. J. Ernst	F. H. Otey	C. A. Wilham
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R. A. Anderson	V. F. Pfeifer	C. Vojnovich
H. F. Conway		

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R. W. Jackson, Chief	R. F. Anderson	A. Ciegler
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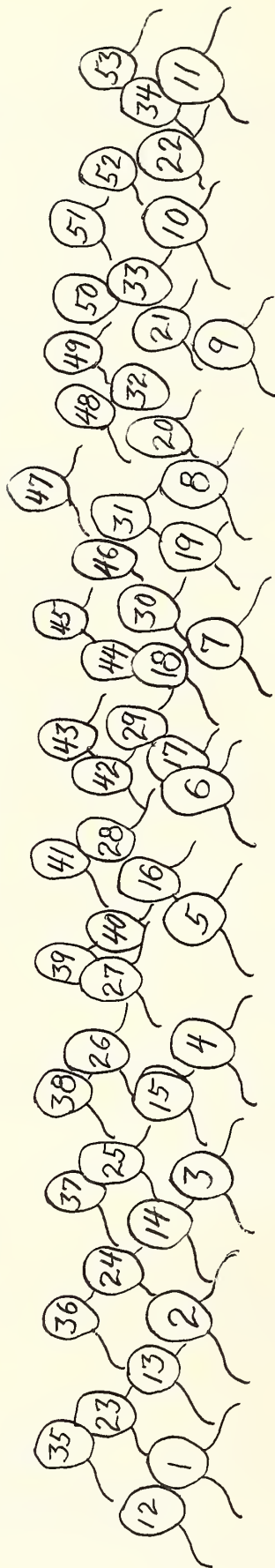
Industrial Crops Laboratory

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Peoria, Illinois
April 3, 1962



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